Can Firms Import Innovation?

The Impact of H-1B Visa Sponsorship on Company Innovation & Performance

By

Bhavesh Viswanath

Abstract:

Immigration policy has always been a controversial topic in the United States of America. There have been studies published on the economic implications of the H-1B visa program but there is a gap in research on the innovation and financial implications for companies that hire H-1B workers. This thesis will focus on measuring the impact of H-1B workers on company performance by creating dynamic panel dataset using data from the Department of Labor and Wharton Research Data Services. This thesis uses simple linear regressions, fixed effects regressions and general methods of moments to measure H-1B employees impact on innovation and company performance. The analysis shows that H-1B employees on average have a positive impact on the research and development spending as well as the operating margin of their employer. This result was consistent with human capital theory assumptions, that more educationally adept workers contribute positively to firms and society. For the US to continue to stay at the forefront of innovation, high skilled labor is required for American companies. As reforms to the H-1B program are being proposed, this thesis aims to begin a conversation on immigration and innovation using empirical evidence.

Keywords: H-1B visas, high skilled immigration, research and development, company performance.

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1. Background & Introduction

Elon Musk (Founder of PayPal, Tesla, and SpaceX), Satya Nadal (CEO of Microsoft), Mike Krieger (Co-Founder of Instagram) were all at one point on the H-1B visa. They have created economic prosperity and have been able to pursue the American Dream. The H-1B program is meant to bring in the best and brightest talent from around the world to generate economic prosperity and innovation. Bill Gates (Co-Founder of Microsoft) testified to the U.S Congress in 2008, where he stated "I want to emphasize that to address the shortage of scientists and engineers, we must do both [reform our education system and our immigration policies]. If we don't, American companies simply will not have the talent they need to innovate and compete." Is this the case? Are these immigrant CEOs and Co-Founders just the exception to the rule? Do foreign workers lead to innovation and a company performing better?

First, research on the high-skilled workforce shortages, the H-1B visa program, and human capital theory was compiled and analyzed for insights on the issues. The literature review shows that the United States has a shortage of skilled workers, specifically in the science, technology, engineering, and mathematics (STEM) fields. Even during the 2008 recession, there were 88,000 unfilled information technology related workers (Peri, and Shih 2014). The labor shortage is explained in more detail in the literature review section.

H-1B visas are temporary work visas for non-citizens. The visa allows high skilled foreigners to work in the United States on a 3-year visa that can be extended for an additional 3 years. The workers must be placed in jobs deemed as a "specialty occupation". This term is broad, stating jobs must be in biotechnology, chemistry, architecture, engineering, mathematics, physical sciences, social sciences, medicine and health, education, law, accounting, business specialties, theology, and the arts. To be sponsored for a visa an employee must hold a minimum of a bachelor's degree. There is a current cap of 85,000 visas that can be rewarded with 20,000 of those reserved for Masters and Doctoral degree applicants. There were 172,500 applications in 2016. When the number of applications exceeds the number of available spots, H-1Bs are approved randomly. The law also states that H-1B employees must

be paid above the prevailing wage for that job to deter "body shopping" or the hiring of cheaper foreign labor. Though there are been some high-profile cases of this with companies such as Disney, research shows that foreign workers earn a premium to their domestic counterparts. (Ruiz, Neil G. (2017))

There have been policy changes to the H-1B program under almost every administration since it's conception in 1990 under George H. W. Bush. When created there was a cap of 65,000 visas. The visas were intended to bring in the talent from abroad, especially in areas where there were skills gaps. In 1998 under Bill Clinton, the cap was increased to 115,000. The cap increased again in 2000 to 195,000 and non-profit research institutions such as universities were exempt from the cap. These increases were due to a growing economy and a technology industry that needed more high-skilled employees than available. In 2004 under George W. Bush's administration, the cap was returned to 65,000 for those with undergraduate degrees and an additional 20,000 visas were available for those with post-graduate degrees. (Ruiz, Neil G. (2017))

By law, companies, not the employee, must pay the visa fees associated with H-1B visa filings. These fees include a $400 Base Fee, $1500 American Competitiveness and Workforce Improvement Act of 1998 Fee, $500 Fraud prevent & detection fee, $500 to $3000 Immigration Attorney Fees, and there is also an optional Premium Processing fee of $1,225. This means the application costs $2400 not including lawyer and premium processing fees per application. (Ruiz, Neil G. (2017))

2. Literature Review:

2.1 Past Research on U.S.A's Skills Gap & H-1B Wages

The topic of H-1B visas is contentious because two claims are made to delegitimize its need. The first is the argument that there is no actual skills gap in the United States. The second claim argues that immigrants lower wages for domestic workers. The two go hand-in-hand and when it is claimed that companies say there is a skills gap so they can hire immigrants at lower wages than their domestic counterparts. According to numerous studies, there is a skills gap in the US for STEM jobs. A 2014 study by UC Davis and Colgate University found that "Firms were unable to fill about 88,000 requested computer-related positions for H-1B workers" in both 2007 and 2008 (Peri, and Shih 2014). This is a surprising statistic when considering 2008 was the beginning of a recession. A more recent study published in 2015 by the U.S Bureau of Labor Statistics summarizes that "the academic sector is generally oversupplied, while the government sector and private industry have shortages in specific areas" (Yi Xue, 2015). The shortages in the private industry include engineers, data scientists, and software developers but there is an oversupply of graduates in chemistry and physics (Yi Xue, 2015). US Congress Joint Economic Committee also released a report titled *STEM Education: Preparing for the Jobs of the Future.* This report states that although the number of STEM degrees is increasing, the percent of total degrees is declining, meaning more people are choosing to pursue non-STEM degrees. The report also states that "the U.S. is failing to produce an ample supply of workers to meet the growing needs of both STEM and non-STEM employers" (US Congress Joint Economic Committee., 2012).

As for wages, by law, companies must pay their H-1B workers the "prevailing wage" or higher for the job that the H-1B employee is performing (Prevailing Wages, 2016). Though there have been cases of H-1B visa abuse, there are significant fines in place to guard against that. For example, Infosys had to pay $34 Million USD for visa abuses in 2013 (Infosys, 2016). Furthermore, a 2010 study in *Management Science* found that "Contrary to the popular belief that foreign workers are a cheap source of labor for U.S. firms, we find that after controlling for their human capital attributes, foreign IT

professionals (those without U.S. citizenship and those with H-1B or other work visas) earn a salary premium when compared with IT professionals with U.S. citizenship" (Mithas and Lucas, 2010)

2.2 Past Research on H-1B Sponsoring Company Performance

Since a company's performance can be measured in many ways it is important to narrow the metrics chosen to assess. Increased innovation, profits, sales, and employees are all aspects that could be used to measure company performance. H-1B employees have varying impacts on each measure.

2.2.1 H-1B visas effect on company level innovation

A study published in the *Journal of Labor Economics* found that based on 77 publicly listed companies, "A 10% growth in the H-1B population corresponded with a 4%–5% higher growth in invention (measured by patents)" (Kerr and Lincoln, 2010). Kerr and Lincoln run city and time fixed effects regressions where patent filings are the dependent variable and the natural log of H-1B hires is the independent variable. A 2014 study by Georgetown and CUNY, Queens College, on "The Impact of Skilled Foreign Workers on Firms: An Investigation of Publicly Traded U.S. Firms" found that the top filers of H-1Bs are "firms that conduct R&D and are heavy users of H-1B workers - they belong to the top quantile among filers of H-1Bs. These empirical findings are consistent with a heterogeneous- firms model where innovation enhances productivity and is subject to fixed costs" (Ghosh, Mayda, and Ortega, 2015). This implies that the innovation by H-1B workers leads to higher levels of productivity for the company. This study also uses firm and time fixed effects but only looks at performance changes between 2001 and 2006. This is because in 2004 there was a policy change to decrease the visa cap from 195,000 to 85,000 visas. Another study published in the *Population Research and Policy Review* assesses a viable solution for the skills gap in IT. By looking at growth in IT jobs using American Electronics Association's data on job growth in high-tech companies, they could come to two basic conclusions:

1. "Failure to increase the H-1B cap and the limits that will place on the ability of American companies to grow and innovate will also limit the growth of jobs available to American workers." (Watts, 2000)

2. “Failure to raise the H-1B cap will aid our foreign competitors by limiting the growth and innovation potential of U.S.” (Watts, 2000)

2.2.2 H-1B visa quota effect on company company performance

The belief that firms that hire H-1B workers are performing better financially because companies pay H-1B workers a lower wage is false. A 2014 study by Georgetown and CUNY, Queens College, mentioned earlier, also found that “if the cap on H-1B visas were relaxed, a subset of firms would experience gains in average labor productivity, firm size, and profits” (Ghosh, Mayda, and Ortega, 2015). This study looked at firm size, sales per employee, gross profits, and R&D expenditures in 2001 and 2006.

2.2.3 H-1B visas effect on employment and wage growth

A UC Davis and Colgate University study found that “H- 1B workers do not displace, but rather complement, natives in computer-related occupations” (Peri and Shih, 2014). This is on a macroeconomic-level though. It is still unclear whether hiring H-1B employees increases the overall company workforce or not. Seeing as H-1B employees are predominantly in IT, it could also be hypothesized that they create efficiencies that would reduce the overall workforce at a company. A study in the *Federal Reserve Bank of Atlanta Economic Review* examined the impact of H-1B workers of wages actually increase and the unemployment rate decreases in the IT sector as H-1B workers are hired. These results were justified by a theory that foreign workers possess different skills than native workers (Zavodny, 2003).

2.3 Past Research on H-1B Employee Satisfaction

The way that the H-1B program is structured makes it inherently stressful for H-1B employees. H-1B employees can only stay on the visa and in the USA as long as they hold their job. The fear of being terminated is worsened by the fear of having to abruptly leave the country. H-1B visa holders can stay in the USA for 3 years and apply for an additional 3-year extension. This is a relatively short time frame so career progression can be difficult. A 2008 study published in the *Journal of Individual Employment*

Rights explores the topic of "Foreigners and Workplace Stress". This paper found that foreign workers have higher job-related stress levels than citizens because of the following 5 factors: "residential insecurity, job insecurity, local social networks, work role ambiguity, and perceived discrimination "(Soylu, 2008). This is one of the only studies done specifically on H-1B employee satisfaction. There are still many unanswered questions pertaining to H-1B employees' workplace stress.

Although there has been prior research on H-1B's impact on wages, employment and innovation there is a research gap in whether the H-1B program can improve a firm's company performance. Moreover, not all H-1B employees work in R&D and may be contributing in ways other than innovation. H-1B employees could be creating more efficient processes within a firm or contribute by ensuring higher quality products. This thesis aims begin filling this void in research on the impact H-1B visas have on innovation and company performance.

2.4 Human Capital Theory

The term "human capital" was coined by economist and Nobel Prize winner Theodore Schultz (Gupta, 2002). He believed that people, firms, and nations should invest in education as it increases employment opportunities and economic growth (Gupta, 2002). Daniel Bell was a sociologist that popularized the term "post-industrial" and emphasized the importance of human capital in an economy that depends less on manufacturing and heavy industry (Hill, 1974). As for more recent studies on human capital's impact on company performance, a 2011 study from the Journal of Applied Psychology explored the "Relationship Between Human Capital and Firm Performance". This study was a meta-analysis of 66 different peer-reviewed studies on the relationship between human capital and firm performance. The study concludes that "managers should invest in programs that increase and retain firm-specific human capital" (Crook, T. R, 2011). H-1B employees are meant to be of high human capital as they are required to have received at least a bachelor's degree. The human capital theory helps hypothesize the impact H-1B employees have on company performance.

3. Research Question & Hypothesis:

1. *What is the impact of H-1B hires for Fortune 500 company on research and development?*

The H-1B program is often promoted because it supposedly fuels innovation in the United States. Therefore, it would be logical to hypothesize that higher rates of H-1B sponsorship correspond with increased research and development spending. The answer to this initial research question and hypothesis helps explain the impact H-1B employees have on incentivizing research that hopefully leads to long-term financial success. The null hypothesis is that companies that have a greater number of H-1B hires do not spend more than those who have a lower number of H-1B hires on research and development.

2. *What is the impact of H-1B hires for Fortune 500 company on company performance?*

Companies that sponsor more H-1B visas will outperform companies that sponsor fewer. This seems to be a logical conclusion based on the literature review and Human Capital Theory. In summary, Human Capital Theory states that a higher skilled and educated workforce creates welfare for firms and society. The study in the Journal of Labor Economics concluded that increased H-1B sponsorship led to higher levels of innovation/patent filings. Furthermore, the Population Research and Policy Review concluded that there is a skills gap in IT. Companies that can hire more IT workers should be performing better than those being harmed by the current skills gap. The major limitation of the studies cited is that they only look at innovation rather than company performance. There is insufficient research on whether these innovations add to the bottom line for the company. Furthermore, most H-1B workers are not working in R&D or developing intellectual property. Financial performance will be measured by using a company's operating margin. The null hypothesis is that companies that have greater H-1B hires do not perform differently than those who have lower H-1B hires.

4. Data and Research Methodology:

4.1 Data Collection:

A data set containing information on H-1B applications made between 2002 and 2015 was obtained from the Department of Labor (DOL). The DOL has been collecting and publishing anonymized H-1B visa application data, regardless of approval status, since 2002. The datasets were combined into a CSV file that was duplicated to combine and count the number of applications from each Fortune 500 company each year.

All financial and operating statistics for Fortune 500 companies from 2002 to 2015 were obtained from University of Pennsylvania's Wharton Research Data Services (WRDS). The data containing how many H-1B visas approved for each company each year was then combined with the financial and operating statistics pulled using WRDS. The dataset also included the industry of each company which plays a large role in the likelihood of employee sponsorship as well as company performance. Binary variables were created for each company to account for all Global Industry Classification Standard Sectors and Industry Groups. (See Appendix 1 for Global Industry Classification Standard).

4.2 Descriptive Statistics and Visualization:

After the dataset was finalized, descriptive statistics were calculated for all relevant variables and were analyzed. Descriptive statistics include mean, standard error, median, standard deviation, range, minimum, maximum, sum, and count. Next, the data was visualized using Microsoft Excel and Tableau. These plots help provide context and insight about the data and help address both research questions. For example, a visualization of H-1B Hires by industry helps provide the context of where high skilled immigrants tend to find employment and why they may. A scatterplot of H-1B Hires and R&D Spending over 15 years helps address the first research question.

4.3 Pairwise Correlation Matrix:

A Pearson Pairwise Correlation Matrix that includes all relevant variables was created. A pairwise correlation matrix shows the relationship two variables have. This includes if they have a positive, negative correlation and how strong the correlation is. The closer to 1 and -1 the correlation, the more highly correlated the two variables are. Two pairwise correlations were run. One where all the relevant variables are linear and one where all the variables are logged. The logged pairwise correlation also contains the descriptive statistics for the logged variables.

4.4 Simple Linear Regressions:

The data was further analyzed to address the two research questions by running linear regressions using the statistical software, R. The first regression analyzes which industries and years have relatively high rates of H-1B Hires. Dummy variables for each industry and year were created. H-1B Hires were scaled taking the natural log so that companies can be compared regardless of size. The same was done for research and development spending. The regression specification is below:

$$\log(H1B\ Approvals) = \beta_0 + + b_2(Industry\ Dummies) + b_3(Year\ Dummies) + u$$

The second regression tries to address the first research question. The regression places R&D Spending as the dependent variable and H-1B Hires, Industry and Time dummies as the independent variables. These variables are logged because there may not be a completely linear relationship between H-1B hires and R&D spending. The regression specification is below:

$$log(R\&D\ Spending) = \beta_0 + \beta_{1l} log(H1B\ Approvals) + b_2(Industry\ Dummies) + b_3(Year\ Dummies) + u$$

4.5 Fixed Effects Regressions:

This study uses econometric methods specifically for panel data. A time and company fixed effects model can control for the differences between companies that do not change over time. This makes comparisons between firms fairer. The fixed effects model controls for unobserved heterogeneity when heterogeneity does not change over time. Examples would be variables that do not vary within each firm over time (e.g. Industry). The heterogeneity is controlled for by taking the first difference (Dranove,

2012). The fixed effects-within model at is used in this study creates estimators for the coefficient in the regression after taking the first difference and adjusting for time-invariant variables. This allows for the generalizations of the coefficients regardless of the firm and industry (Dranove, 2012).

To measure the impact of H-1B Hires on R&D Spending, a company and time fixed effects regression with a lag dependent variable is used. This means that the industry no longer can be used as a variable since it does not change for a company over time. This is another key difference between the simple linear regressions and fixed effects regressions. H-1B Hires on R&D Spending will still be logged to scale for size and extreme values. The lag dependent variable is included to safeguard from omitted variable bias. Essentially, it is very likely that last year's R&D Spending explains a lot of this year's R&D Spending for each firm. The regression specification is below:

$$\log(R\&D\ Spending)_{it} = \beta_0 + \log(R\&D\ Spending)_{i(t-1)} + \beta_1 \log(H1B\ Approvals)_{it} + \beta_2 \log(Employess)_{it} + \beta_3 log(Advertising\ Spending)_{it} + \beta_4 \log(Capital\ Expenditure)_{it} + \sum_{2002}^{2015} \xi_x (Year) + \mu$$

The fourth regression aims to directly address the second research question of H-1B employees impact on company performance using operating margin as the dependent variable. Operating Margin was selected as the dependent variable because it focuses on operational efficiency. Operating margin helps assess how H-1B workers impact price and operations. The independent variables included H-1B Approval, R&D, Employees, Advertising Spending, Capital Expenditure and time dummies. The total employees variable controls for changes in firm size and provides a comparison to H-1B Hires. Advertising Spending controls for increases in price and Capital Expenditure controls for increased operational efficiency. Research and development is a mix of both.

This regression also uses a company and time fixed effects to control for aspects that do not vary between time and companies. A lagged dependent variable is also used in this regression to safeguard against omitted variable bias. It should also be noted that the dependent variables are all logged. This is because there may not be a completely linear relationship between Operating Margin and expenditure. For example, a $2 million increase in R&D may have a larger impact if the increase is from a budget of $1 million, rather than $100 million.

$$OperatingMargin_{it} = \beta_0 + OperatingMargin_{i(t-1)} + \beta_1 \log(H1B\ Approvals)_{it} + \beta_2 log(R\&D\ Spending)_{it} + \beta_3 \log(Advertising\ Spending)_{it} + \beta_4 \log(Capital\ Expenditure)_{it} + \sum_{2002}^{2015} \xi_x(Year) + \mu$$

4.6 General Methods of Moments Estimator:

The fixed effects regression takes advantage of a static panel. A dynamic panel uses lagged levels of the dependent variables as regressors because a way to understand a company's operating margin this year is by looking at last years. Doing this though violates the exogeneity assumption for the regression. The general methods of moments (GMM) method aims to work around this so that the exogeneity assumption isn't violated by taking the first difference of the regression just as is done with a fixed effects regression and then more lags of the dependent variable are used as instrumental variables for the lagged dependent variables. This method fits a linear regression to a dynamic panel where unobserved heterogeneity in the panel correlates with lags of the dependent variable (Arellano and Bond, 1991) (Arellano and Bover, 1995). This GMM/Arellano-Bond estimator is meant for dynamic panels with few time periods but many individual units (e.g. firms) (Arellano and Bover, 1995). The regression specifications are below:

$$R\&D\ Spending_{it} = \beta_0 + R\&D\ Spending_{i(t-1)} + \beta_1 \log(H1B\ Approvals)_{it} + \beta_2 \log(Employess)_{it} + \beta_3 log(Advertising\ Spending)_{it} + \beta_4 \log(Capital\ Expenditure)_{it} + \sum_{2002}^{2015} \xi_x(Year) + \sum_{j=1}^{j=115} y_j\ (Companies)_i + \mu$$

$$OperatingMargin_{it} = \beta_0 + OperatingMargin_{i(t-1)} + \beta_1 \log(H1B\ Approvals)_{it} + \beta_2 \log(Employees)_{it} + \beta_3 \log(R\&D\ Spending)_{it} + \beta_3 log(Advertising\ Spending)_{it} + \beta_4 \log(Capital\ Expenditure)_{it-1} + \sum_{2002}^{2015} \xi_x(Year) + \sum_{j=1}^{j=120} y_j\ (Companies)_i + \mu$$

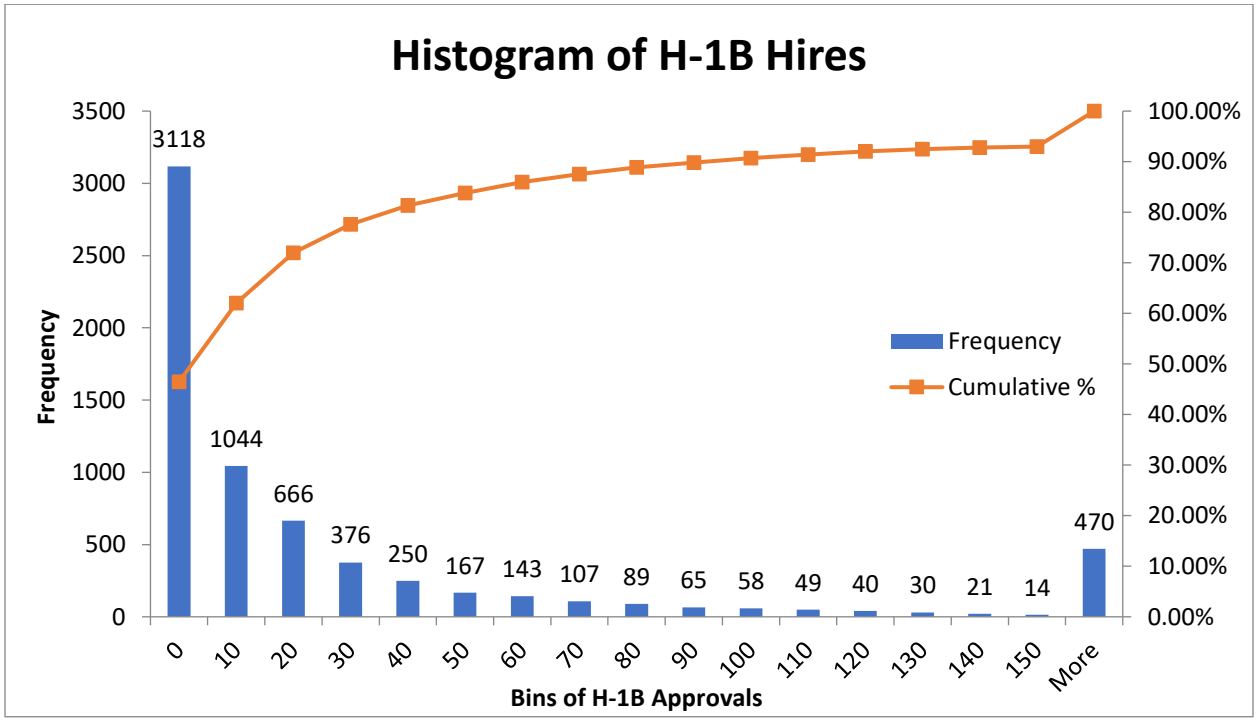
5. Analysis & Results:

5.1 Descriptive statistics:

Below are the descriptive statistics for relevant variables in the dataset. The mean of the H-1B Hires for a Fortune 500 company in any given year would be 59. It should also be noted that the standard deviation of 271 for H-1B Hires is significantly larger than the mean. This is partially due to 3118 data points of the 6707 having no H-1B Hires. Another reason for the large variation is because there are a few companies that have H-1B Hires in the thousands each year. The variation of H-1B Hires is more clearly shown in the histogram below.

	Operating Margin	*H1B Approvals*	*Employees*	*R&D*	*Capital Expenditure*	*Advertising Expense*
Mean	0.166	59	55,924	$352	$1,162	$218
Standard Error	0.0019	3	1,420	$14	$34	$8
Median	0.138	4	27,000	$0	$362	$0
Mode	#N/A	0	25,000	$0	$0	$0
Standard Deviation	0.149	271	115,630	$1,177	$2,624	$672
Range	4.43	6212	2,300,000	$12,540	$38,315	$9,729
Minimum	-3.43	0	0	$0	-$330	$0
Maximum	1.00	6212	2,300,000	$12,540	$37,985	$9,729
Sum	994	396126	371,002,155	$2,361,707	$7,012,224	$1,465,037
Count	6002	6707	6634	6,707	6,036	6,707
				In Millions		

Table 1: Descriptive Statistics



Another point to note from the descriptive statistics is the number of Research and Development Spending observations. There are only 2328 data points because not all companies have an R&D budget or they did not report it. There were also 7 companies that listed 0 employees because they are holding companies and is the reason the minimum for Employees in the dataset is 0. However, these 7 companies only represent 39 data points out of 6707 and therefore should not have a significant impact on the analysis.

5.2 Visualizations:

Various plots were created to better understand relationships between variables. Figure 1, shows the increase in both R&D Spending and H-1B Hires over time. The impact of the great recession is also made clear when looking at 2009. There was a slight drop in R&D Spending and a sharp drop in H-1B Hires.

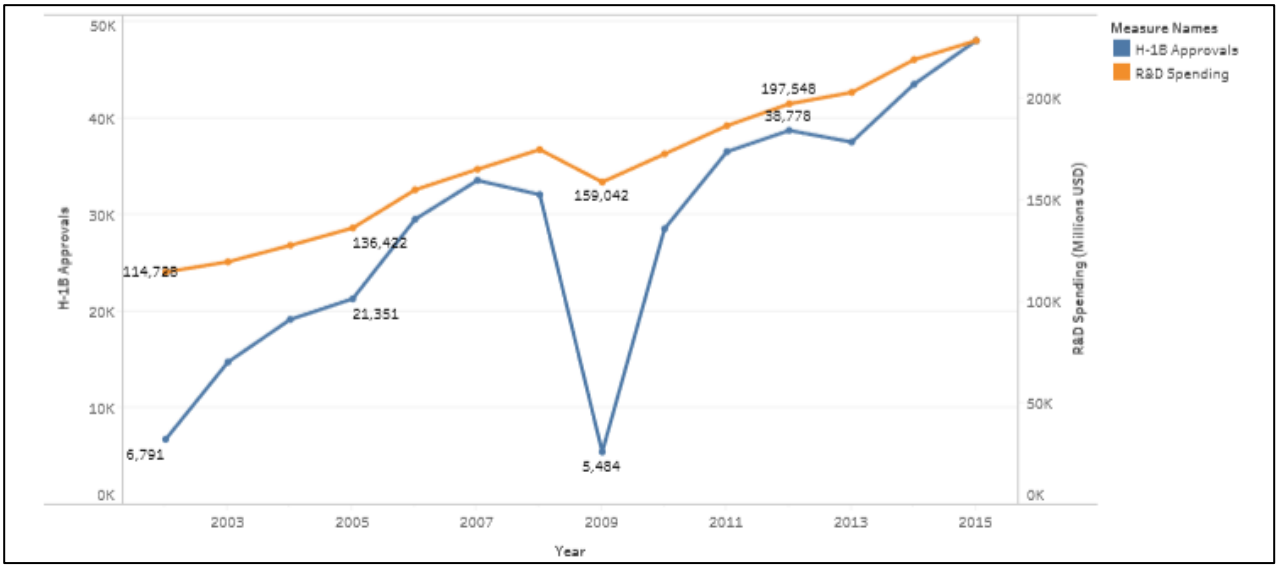


Figure 1:H-1B Hires and R&D Spending for Fortune 500 Companies from 2002 to 2015

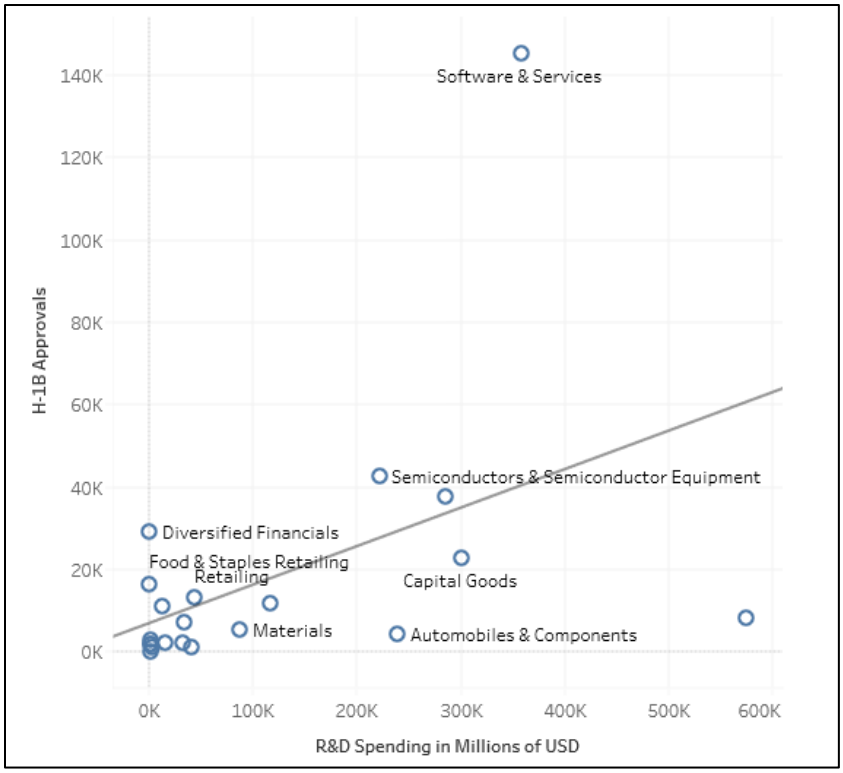


Figure 2: Total H-1B Hires and R&D Spending by Industry from 2002 and 2015

Figure 2 examines which industries have had larger amounts of H-1B Hires and R&D spending. Software and hardware related industries have significantly larger numbers of H-1B Hires which may be attributed to the shortage of technology workers in the USA, as mentioned by Bill Gates in front of the US Congress. As shown, there is a positive correlation between R&D Spending and H-1B Hires.

The largest value for R&D Spending is within the Pharmaceuticals, Biotechnology & Life Sciences industry, as one would expect. The trendline has an R^2 value of .21, which means we can explain 21% of the variation in the data. The Retail industry is closest to the line of best fit and is near the median for both H-1B Hires and R&D Spending, therefore, it will be used as the base/comparison variable in the regressions to come.

5.3 Pairwise Correlation Matrix Results:

The correlation matrix below shows the linear relationship between all variables. It is interesting to note that the strongest relationship is between R&D spending and H-1B Hires. The positive nature of the relationship matches the graph of H-1B Hires and R&D Spending by industry above. In this correlation matrix, all variables have a positive relationship with Operating Margin. R&D Spending and H-1B Hires have the strongest relationship with Operating Margin though.

	Operating Margin	H1-B Approvals	R&D Spending	Employees	Advertising Spending	Capital Expenditure
Operating Margin	1					
H1-B Approvals	0.2693	1				
R&D Spending	0.369	0.5312	1			
Employees	0.0177	0.2863	0.4155	1		
Advertising Spending	0.1306	0.1131	0.5102	0.4627	1	
Capital Expenditure	0.1075	0.1998	0.4448	0.5184	0.5252	1

Matrix 1: Linear Correlation Matrix

The correlation matrix below includes the relationship of the logged variables (Operating Margin was not logged). Almost all the relationships are stronger in this matrix. This may provide justification for using a log-log model. Interestingly, the sign for the Employees – Operating Margin relationship changed when Employees was logged but this is very close 0 so the relationship not very strong in general.

	Mean	Std. Dev.	Min	Max	Operating Margin	H1-B Approvals	R&D Spending	Employees	Advertising	Cap-Ex
Operating Margin	0.199	0.118	-0.094	0.712	1					
H1-B Approvals	2.877	2.272	0.000	8.734	0.2738	1				
R&D Spending	5.894	1.852	-0.658	9.437	0.4252	0.6671	1			
Employees	10.225	1.176	3.951	14.648	-0.0054	0.2809	0.418	1		
Advertising Spending	5.527	1.674	0.000	9.183	0.2372	0.2241	0.4183	0.5469	1	
Capital Expenditure	6.271	1.297	3.124	10.127	0.2825	0.4721	0.6346	0.7038	0.62	1

Matrix 2: Logged Descriptive Statistics & Correlation Matrix

5.4 Linear Regression Results:

The first regression model was created to understand which industry and years have significant H-1B Hires. 2015 is used as the based year that other years are compared to because it is the most recent year in the dataset. The Retail industry was used as the base for comparison to other industries as the diagram above showed retail as an industry with a median H-1B Approval amount and R&D Spending. The complete regression results can be seen in Appendix 3. Industries with the largest coefficients are Semiconductors, Software, and Hardware in that order, with all industries statistically significant at the 1% level. This reaffirms that software industries have significantly higher rates of H-1B Hires. Interestingly, Pharmaceuticals, Biotechnology & Life Sciences industry has a statistically significant number of H-1B Hires and the fourth largest coefficient in the regression. The effects of economic downturns are also evident in this regression. 2002 and 2009 were years that had statistically significant negative H-1B coefficients. This is logical since the H-1B visa serves to fill skills gap for employers but

an economic downturn leads to fewer jobs needed. Furthermore, employers may be less inclined to pay for the fees associated with H-1B employees during a financially difficult time.

To develop an understanding of the relationship between H-1B sponsorship effect on research and development spending another linear regression was run. The full results of the regression can be seen in Appendix 4. The results show that H-1B Hires have a positive relationship with R&D spending. A one percent increase in H-1B Approval corresponds with a .415 percent increase in R&D Spending. This was statistically significant at a confidence level of 1%. This provides insight into the first research question. The regression shows H-1B hires do have an impact on R&D spending.

Not surprising the Pharmaceutical industry has the highest coefficient among the industries for R&D Spending. The semiconductor industry had the second largest coefficient with Software and Hardware having the third and fourth highest coefficients. This is noteworthy because these same industries had relatively large coefficients in the previous regression where H-1B Hires was the dependent variable.

5.5 Fixed Effects Regressions & General Methods of Moments Estimation:

Using a simple linear regression does not take advantage of the time series data that was obtained. To better understand if H-1B visas increase R&D Spending, a company and time fixed effects regression was run and the full results can be seen in Appendix 5. The lag dependent variable shows that last year's R&D spending explains about 57% of this year's R&D Spending. As mentioned in the previous section, the lag dependent variable helps control for omitted variable bias. The regression coefficient of 0.0178 can be interpreted as a one percent increase in H-1B Hires results in a 0.0178% increase in R&D Spending.

As seen in Table 2, using a fixed effects model does not result in statistical significance. This may be partially due to a fixed effects model not being the best fit for an unbalanced dynamic panel with relatively few observations. A fixed effects regression may not be the most valid with this panel because

the exogeneity assumption may not hold because the error term and H-1B Hires may still be correlated. The GMM method, developed by Arellano, Bond, Blundell, and Bover, allows us to lag the independent variables and instrument for previous years. The Arellano–Bond GMM method takes the first difference of the regression equation. For these reasons, the GMM model allows us to explain the impact of H-1Bs on R&D Spending with more confidence. The GMM model shows that a 1% increase in H-1B Hires results in a nearly .04% increase in R&D. This result is significant beyond a 99% confidence level. Interesting, Capital Expenditure is also statistically significant at this level. The full regression results using the GMM method can be seen in Appendix 6.

Table 2. Determinants of R&D – Fixed Effects & GMM Models		
	Fixed Effects	**GMM**
	Natural Log of R&D Spending	**Natural Log of R&D Spending**
Lagged Natural Log of R&D Spending	0.567***	0.902***
	(0.0384)	(0.0308)
Natural Log of H-1B Hires	0.0178	0.0425**
	(0.0134)	(0.0194)
Natural Log of Employees	0.173**	0.0112
	(0.0690)	(0.0822)
Natural Log of Advertising Expense	0.0892**	0.0606
	(0.0436)	(0.042)
Natural Log of Capital Expenditure	0.109***	0.161***
	(0.0234)	(0.0432)
Constant	-0.419	-1.04
	(0.533)	(1.321)
N	920	920
Note: Standard errors in parentheses; *p<0.1, **p<0.05, ***p<0.01		

Table 3. Determinants of Operating Margin – Fixed Effects & GMM Models		
	Fixed Effects	**GMM**
	Operating Margin	Operating Margin
Lag Operating Margin	0.507***	0.642***
	(0.0633)	(0.0918)
Natural Log of H-1B Hires	0.000518	0.00357*
	(0.00112)	(0.00219)
Natural Log of Employees	-0.00336	0.00844
	(0.00659)	(0.0146)
Natural Log of R&D Spending	-0.00279	0.0110
	(0.00708)	(0.00868)
Natural Log of Advertising Expenses	-0.0104***	-0.00245
	(0.00366)	(0.00709)
Natural Log of Capital Expenditure	0.0140**	-0.00197
	(0.00573)	(0.00780)
Constant	0.150	-0.123
	(0.102)	(0.221)
N	933	933
*Note: Standard errors in parentheses; *p<0.1, **p<0.05, ***p<0.01*		

A fixed effects regression was created to estimate the impact of H-1B employees on Operating Margin. The full regression results can be seen in Appendix 6. The year dummies in fixed effects regression results reaffirm the impact of the recession on company performance. Years 2002, 2008 and 2009 all have relatively large negative coefficients. Almost all the coefficients for the year dummies are negative because 2015 is used as the base year. The overall economy was healthy in 2015. The fixed effects regression results also show that H-1B Hires and Capital Expenditure have a positive relationship with Operating Margin whereas R&D Spending, Employees, Advertising Spending have a negative relationship. This could be interpreted as R&D, regular employees and Advertising Expenditure are

expenses and have a net negative impact on the financial statement but H-1B Employees, and Capital Expenditure cover the cost of the investment and provide value to the firm. An issue is that is the independent variables such as R&D are a short-term expense but the benefits may only be seen with time. These results may provide a reason for lagging the independent variable. Furthermore, the H-1B Hires standard error is larger than the coefficient which means H-1B Hires result is not statistically significant and there is high uncertainty in the model.

A GMM model was created to address the issues of endogeneity, similarly to the R&D model. We can also see that the lag of one year explains 64% of the Operating Margin for the next year. The regression results show that H-1B Hires, R&D Spending, and Employees have a positive relationship with Operating Margin whereas Capital Expenditure and Advertising Spending have a negative relationship. The H-1B Approval coefficient can be interpreted as a one percent increase in H-1B Hires for a firm leads to a .0035 percentage point increase in Operating Margin. This is significant considering that the mean Operating Margin for the dataset is .165 a year from the increase. This is also statistically significant at a 90% confidence level. It should also be noted that robust standard errors were used for all fixed effects and GMM estimations. The full results can be seen in Appendix 8.

It is also interesting to note that the coefficient for Employees is larger than H-1B Hires. The model estimates that a one percent increase in total employees leads to a 0.84 percentage point increase in Operating Margin. This is slightly misleading since H-1B employees count towards the total employee count. This issue will be explored in more detail in the discussion section. Another issue is that the estimated effect of total employees on operating margin is highly uncertain and statistically insignificant. R&D Spending, Advertising, Capital Expenditure, and Employees are all statistically insignificant and have high uncertainty. These variables are control variables; therefore, the uncertainty of the coefficients is not as important as the H-1B Hires coefficient estimate.

5.6 Regression Diagnostic Tests:

Hausman tests were performed to validate the use of a fixed effects regression over a random effect regression. The null hypothesis in this test is that a random effects model is appropriate and the alternative hypothesis is that a fixed effects model is appropriate. This test was run for the R&D Spending and Operating Margin dependent variable regressions. Both tests resulted in a rejection of the null hypothesis, therefore, a fixed effects model is more appropriate. The Hausman test results can be seen in Appendix 8.

6. Discussion:

The results from the linear regression show that the null hypothesis that H-1B Hires have no impact on R&D Spending can be rejected beyond a 1% significance level. A one percent increase in H-1B Hires leads to a 0.042 percent increase in R&D spending, according to the GMM regression. If it is true that investment in R&D leads to innovation, it may be suggested that H-1B hires lead to greater innovation. This conclusion is also consistent with a study published in the Journal of Labor Economics on "the impact of high-skilled immigrants on U.S. technology formation" found that "A 10% growth in the H-1B population corresponded with a 4%–5% higher growth in invention" (Kerr and Lincoln, 2010). "Inventions" was measured by patent filings.

These results provide show that companies looking to invest in innovation require an investment in human capital. The extra cost of hiring foreign labor for research and development purposes may be worthwhile but this too needs to be further explored. Alternatively, it could be argued that increased R&D spending does not mean increased innovation. Spending more money does not guarantee innovation. The 2010 Kerr and Lincoln study in the literature review, can be used as supporting evidence that R&D Spending serves as a valid instrument for innovation as measured by patent filings.

The second null hypothesis that H-1B Hires have no effect on company performance measured by operating margin can be rejected beyond a 10% significance level. A one percent increase in H-1B Hires leads to a 0.0035 percentage point increase in a firm's operating margin. Human capital theory explains

why firms perform better with H-1B employees. As the U.S economy becomes more service and technology-oriented, education and human capital are key to sustaining growth. This notion was first popularized by sociologist Daniel Bell in the 1970s when he used the term "post-industrial" to describe an economy that no longer relies on manufacturing and heavy industry. In Bell's book *The Coming of Post-Industrial Society*, he emphasizes that the economy to come will require a more highly educated workforce (Hill, R. (1974)). Essentially, a company can perform better when the human capital requirements are met.

An alternative explanation to these findings would be that H-1B employees are underpaid compared to their non-immigrant equivalents. If this were the case then operating margin would be positively affected since less would be spent on wages. Although underpaying H-1B employees is illegal, there have been numerous cases of this kind of visa abuse. That said, most of these abuses are not by publicly listed American companies, therefore, this study should be largely unaffected by the issue of visa abuse. Similarly, it is often argued that the H-1B program brings wages down for high skilled domestic workers by increasing the supply of workers. Lower wages would have a positive impact on operating margin. The visa is only allowed if the job is unable to be filled by a domestic worker. Thus, wages should not be impacted since the position could not be filled by a domestic worker in the first place.

As mentioned in the introduction, there have been numerous policy changes throughout the H-1B program's history and there continue to be proposals varying from a total elimination of the program to an expansion. Though there needs to be stricter enforcement rules pertaining to outsourcing, there is also a clear need for high skilled immigrants as they keep the U.S at the forefront of innovation. These innovations and employees lead to higher performing companies and overall U.S economy. When H-1B policy is being discussed the goal should be to ensure that the U.S is able to meet labor demands, hire the best and brightest while not displacing American workers. This study shows that there is a demand for high skilled immigrants and that they aid in a company's innovation and company performance.

There is much to expand on upon with this study. The dataset can and should be expanded beyond the Fortune 500 and beyond the timeframe of 2002-2015. Part of the reason for using more complex models and the lack of confidence with many of the estimators is due to the lack of longitudinal data. As time progresses, the impact of H-1B hires will be even more clear. Furthermore, this study was only able to lag the independent variables one year because further lags caused data insufficiency issues. With an expanded longitudinal dataset, these lags would be possible and the true impact of H-1B hires and R&D spending may be clear. As mentioned in the data collection section, H-1B application data exist for each application from each year. This allows the dataset to be expanded beyond the Fortune 500 companies. This would be beneficial to the study but due to time constraints, the data was limited to the 500 largest public companies over 14 years.

Another issue regarding the data would be that the "Employees" variable measures total employees in each year whereas H-1B Hires measures the number of H-1B employees approved in each year, not the total number of H-1B employees working in the given year. This makes it more difficult to compare regular employees and H-1B employees impact on company performance. Ideally, the dataset would have information on how many H-1B employees were working for each firm each year. This would also allow for an H-1B employee to total employee ratio which would be another way to assess the impact of high skilled immigrants.

This study could also be further by expanding on company performance. This study focuses on operating margin but there are other metrics that can be explored as well such as return on assets. There is also more to be explored with how H-1B hires are related to research and development. It is still somewhat unclear if one causes the other or if they are merely correlated.

7. Conclusion:

The primary objective of this thesis is to assess the impact of H-1B employees on company performance. The analysis shows that H-1B employees on average have a positive impact on the operating margin of their employer. Shortages of technology and healthcare workers could be part of the reason why those industries tend to have significantly higher H-1B hires. This result was rationalized by using human capital theory and understanding the labor and economic landscape. The analysis also showed that H-1B employees tend to increase R&D spending which means they are helping innovation. This conclusion was supported by prior studies as well. There is growing demand for high-skilled workers in the U.S and the H-1B visa serves as one way to address the demand.

The H-1B visa has been a controversial political topic mostly due to the issue of visa fraud and outsourcing. There is still a long way to go to reduce fraud and ensure the visas are used for the intended purposes but what is often not discussed is the benefits the legal employees provide to their employer and the national economy. The conclusions from this study show the H-1B program increases American innovation and losing out on talent when there is a shortage of high skilled workers worsens performance for firms and the economy.

As mentioned in the discussion section, there are still areas for further research. Not only can this study be expanded but new studies on immigration policy should be explored. Immigration has been at the forefront of the U.S election, Brexit, and the global refugee crisis. Immigration research must be pursued urgently to ensure that the policy decisions made are supported by empirical evidence.

Appendix 1: Variables from Wharton Research Data Services for Fortune 500 Companies

Variable Name	Type	Description
gvkey	Char	Global Company Key
datadate	Num	Data Date
fyear	Num	Data Year - Fiscal
tic	Char	Ticker Symbol
conm	Char	Company Name
gsector	Num	Global Industry Classification Standard Classification Sector
ggroup	Num	Global Industry Classification Standard Classification Industry Group
act	Num	Current Assets - Total
ao	Num	Assets - Other
aqc	Num	Acquisitions
capsft	Num	Capitalized Software
capx	Num	Capital Expenditures
ch	Num	Cash
cogs	Num	Cost of Goods Sold
dvt	Num	Dividends - Total
ebit	Num	Earnings Before Interest and Taxes
ebitda	Num	Earnings Before Interest
eiea	Num	Equity in Earnings - After-Tax
emp	Num	Employees
lct	Num	Current Liabilities - Total
lt	Num	Liabilities - Total
ni	Num	Net Income (Loss)
niint	Num	Net Interest Income
revt	Num	Revenue - Total
sale	Num	Sales/Turnover (Net)
utme	Num	Maintenance Expense - Total
xacc	Num	Accrued Expenses
xad	Num	Advertising Expense
xago	Num	Administrative and General Expense - Other
xagt	Num	Administrative and General Expense - Total
xlr	Num	Staff Expense - Total
xpp	Num	Prepaid Expenses
xrd	Num	Research and Development Expense
xrdp	Num	Research & Development - Prior

Appendix 2: Global Industry Classification Standard Classification

Sector		Industry Group	
10	Energy	1010	Energy
15	Materials	1510	Materials
20	Industrials	2010	Capital Goods
		2020	Commercial & Professional Services
		2030	Transportation
25	Consumer Discretionary	2510	Automobiles & Components
		2520	Consumer Durables & Apparel
		2530	Consumer Services
		2540	Media
		2550	Retailing
30	Consumer Staples	3010	Food & Staples Retailing
		3020	Food, Beverage & Tobacco
		3030	Household & Personal Products
35	Health Care	3510	Health Care Equipment & Services
		3520	Pharmaceuticals, Biotechnology & Life Sciences
40	Financials	4010	Banks
		4020	Diversified Financials
		4030	Insurance
		4040	Real Estate
45	Information Technology	4510	Software & Services
		4520	Technology Hardware & Equipment
		4530	Semiconductors & Semiconductor Equipment
50	Telecommunication Services	5010	Telecommunication Services
55	Utilities	5510	Utilities
60	Real Estate	6010	Real Estate

Appendix 3: Linear Regression results of H-1B Hires in relation to Industry and Year

Dependent variable:

	Logged H-1B Hires
Energy	0.281***
	(0.104)
Materials	0.327***
	(0.105)
Capital_Goods	0.923***
	(0.096)
Commercial_Professional	0.045
	(0.170)
Transport	0.437***
	(0.127)
Automobile	1.082***
	(0.148)
Consumer_Durable	0.016
	(0.133)
Consumer_Service	0.462***
	(0.152)
Media	0.123
	(0.130)
Food_Retailing	1.015***
	(0.130)
Food_Beverage_Tobacco	-0.067
	(0.112)
Household	1.132***
	(0.192)
Health_Care	0.923***
	(0.106)
Pharma	1.840***
	(0.148)
Banks	1.659***
	(0.133)
Financials	1.531***
	(0.127)
Insurance	0.183
	(0.123)
Software	3.375***
	(0.128)
Hardware	2.168***
	(0.119)
Semiconductors	4.472***
	(0.192)
Telecomm	1.886***
	(0.177)
Utilities	-0.363***
	(0.106)
Real_Estate	0.077
	(0.270)
2002	-0.922***
	(0.110)
2003	-0.531***
	(0.110)
2004	-0.286***
	(0.110)
2005	-0.221**
	(0.110)
2006	-0.037
	(0.110)
2007	-0.021
	(0.110)
2008	-0.054
	(0.110)
2009	-1.138***
	(0.110)
2010	-0.194*
	(0.110)
2011	-0.012
	(0.110)
2012	-0.028
	(0.110)
2013	-0.027
	(0.110)
2014	0.076
	(0.110)
Constant	1.241***
	(0.102)
Observations	6,707
R^2	0.268
Adjusted R^2	0.264
Residual Std. Error	1.692 (df = 6670)
F Statistic	67.911*** (df = 36; 6670)
Note:	*p<0.1; **p<0.05; ***p<0.01

Appendix 4: Linear Regression results of R&D Spending in relations to H-1B Hires, Industry and Year

	Natural Log of R&D Spending
ln.H1B	0.415***
	(0.014)
Energy	-0.346
	(0.276)
Materials	-0.314
	(0.265)
Capital_Goods	0.677***
	(0.262)
Commercial_Professional	-0.710*
	(0.377)
Transport	
Automobile	0.963***
	(0.271)
Consumer_Durable	0.089
	(0.288)
Consumer_Service	-1.988***
	(0.338)
Media	-0.282
	(0.387)
Food_Retailing	-4.533***
	(0.829)
Food_Beverage_Tobacco	-0.275
	(0.271)
Household	0.251
	(0.283)
Health_Care	0.969***
	(0.274)
Pharma	2.224***
	(0.270)
Banks	
Financials	-1.353
	(1.142)
Insurance	
Software	0.675**
	(0.271)
Hardware	0.530**
	(0.266)
Semiconductors	1.029***
	(0.280)
Telecomm	0.106
	(0.383)
Utilities	-1.094*
	(0.612)
Real_Estate	-0.862**
	(0.394)
2002	-0.082
	(0.125)
2003	-0.368***
	(0.124)
2004	-0.420***
	(0.123)
2005	-0.370***
	(0.122)
2006	-0.349***
	(0.123)
2007	-0.359***
	(0.122)
2008	-0.281**
	(0.121)
2009	0.313**
	(0.124)
2010	-0.165
	(0.122)
2011	-0.200
	(0.122)
2012	-0.134
	(0.123)
2013	-0.126
	(0.124)
2014	-0.077
	(0.124)
Constant	4.353***
	(0.276)
Observations	2,328
R^2	0.577
Adjusted R^2	0.571
Residual Std. Error	1.108 (df = 2293)
F Statistic	92.060*** (df = 34; 2293)
Note:	*p<0.1; **p<0.05; ***p<0.01

Appendix 5: Fixed Effects Regression of R&D Spending in relation to H-1B Approval, Employees, Advertising Spending, and Capital Expenditure

Fixed-effects (within) regression — Number of obs = 920
Group variable: gvkey — Number of groups = 115

R-sq: within = 0.8317 — Obs per group: min = 1
between = 0.9329 — avg = 8.0
overall = 0.9285 — max = 13

F(16,114) = 87.40
corr(u_i, Xb) = 0.6797 — Prob > F = 0.0000

(Std. Err. adjusted for 115 clusters in gvkey)

ln_xrd	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_xrd						
L1.	.5668085	.0383712	14.77	0.000	.4907955	.6428215
ln_H1B	.0178012	.0134477	1.32	0.188	-.0088385	.0444409
ln_emps	.1733259	.0689831	2.51	0.013	.036671	.3099808
ln_ads	.0891989	.0435546	2.05	0.043	.0029176	.1754803
ln_capx	.1090491	.0234366	4.65	0.000	.0626214	.1554768
y2003	-.0722183	.0351755	-2.05	0.042	-.1419007	-.0025359
y2004	-.0688145	.0313546	-2.19	0.030	-.1309277	-.0067012
y2005	-.0568291	.0291653	-1.95	0.054	-.1146053	.0009472
y2006	-.0610999	.0283413	-2.16	0.033	-.1172437	-.0049561
y2007	-.0399043	.0260869	-1.53	0.129	-.0915822	.0117736
y2008	-.0595711	.0213796	-2.79	0.006	-.1019239	-.0172182
y2009	-.0257791	.0409374	-0.63	0.530	-.1068759	.0553176
y2010	.0053379	.0154979	0.34	0.731	-.0253634	.0360392
y2012	.0001824	.0145044	0.01	0.990	-.0285507	.0289155
y2013	-.0249755	.026326	-0.95	0.345	-.0771271	.027176
y2014	.0097316	.0164181	0.59	0.555	-.0227924	.0422557
_cons	-.4187028	.5334294	-0.78	0.434	-1.475422	.6380167
sigma_u	.71293681					
sigma_e	.15309585					
rho	.95591954	(fraction of variance due to u_i)				

Notes:
ln_xrd represents the natural log of research and development spending;
ln_H1B represents natural log of H-1B hires

Appendix 6: General Method of Moments Estimation of R&D Spending in relation to H-1B Hires, Employees, Advertising Spending, and Capital Expenditure

System dynamic panel-data estimation — Number of obs = 920
Group variable: gvkey — Number of groups = 115
Time variable: fyear
Obs per group: min = 1, avg = 8, max = 13
Number of instruments = 107 — Wald chi2(17) = 3298.37
Prob > chi2 = 0.0000
One-step results

ln_xrd	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
ln_xrd						
L1.	.9016374	.0307568	29.32	0.000	.8413552	.9619197
ln_H1B	.042524	.0193535	2.20	0.028	.0045917	.0804562
ln_emp	.0112171	.0821747	0.14	0.891	-.1498423	.1722765
ln_ads	.0605518	.0419703	1.44	0.149	-.0217085	.142812
ln_capx	.1610065	.0431531	3.73	0.000	.0764281	.245585
y2003	.0518887	.0435888	1.19	0.234	-.0335438	.1373213
y2004	.0368334	.0283831	1.30	0.194	-.0187964	.0924633
y2005	.0192444	.029038	0.66	0.508	-.0376691	.0761579
y2006	-.0087361	.0412151	-0.21	0.832	-.0895162	.072044
y2007	.0123104	.0392358	0.31	0.754	-.0645903	.0892112
y2008	-.0623892	.0325779	-1.92	0.055	-.1262407	.0014623
y2009	.013445	.0531296	0.25	0.800	-.090687	.1175771
y2010	.0173217	.0169444	1.02	0.307	-.0158887	.0505322
y2012	-.026689	.0262246	-1.02	0.309	-.0780883	.0247103
y2013	-.034818	.0299425	-1.16	0.245	-.0935042	.0238682
y2014	-.0387488	.0299536	-1.29	0.196	-.0974567	.0199592
y2015	-.0672525	.0341634	-1.97	0.049	-.1342115	-.0002935
_cons	-1.040496	1.320882	-0.79	0.431	-3.629377	1.548386

Instruments for differenced equation
GMM-type: L(2/.).ln_xrd
Standard: D.ln_H1B D.ln_emp D.ln_ads D.ln_capx D.y2003 D.y2004 D.y2005 D.y2006 D.y2007 D.y2008 D.y2009 D.y2010 D.y2012 D.y2013 D.y2014 D.y2015
Instruments for level equation
GMM-type: LD.ln_xrd
Standard: _cons

Appendix 7: Fixed Effects Regression of Operating Margin in relation to H-1B Hires, Employees, R&D, Advertising Spending, and Capital Expenditure

```
Fixed-effects (within) regression               Number of obs      =       933
Group variable: gvkey                           Number of groups   =       120

R-sq:  within  = 0.3598                         Obs per group: min =         1
       between = 0.9293                                        avg =       7.8
       overall = 0.8681                                        max =        13

                                                F(18,119)          =     16.01
corr(u_i, Xb)  = 0.8299                         Prob > F           =    0.0000

                                  (Std. Err. adjusted for 120 clusters in gvkey)
```

OpMargin	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
OpMargin						
L1.	.5070294	.0633362	8.01	0.000	.3816173	.6324415
ln_H1B	.0005176	.0011199	0.46	0.645	-.0016998	.0027351
ln_emp	-.0033605	.0065861	-0.51	0.611	-.0164017	.0096807
ln_xrd	-.0027864	.0070831	-0.39	0.695	-.0168117	.0112389
ln_ads	-.0103929	.0036629	-2.84	0.005	-.0176459	-.0031399
ln_capx	.0139895	.005735	2.44	0.016	.0026337	.0253453
y2002	0	(omitted)				
y2003	-.0099887	.0058086	-1.72	0.088	-.0214903	.0015129
y2004	-.0079335	.005777	-1.37	0.172	-.0193726	.0035055
y2005	-.0089606	.0054103	-1.66	0.100	-.0196736	.0017523
y2006	-.0146229	.0050318	-2.91	0.004	-.0245864	-.0046594
y2007	-.0128461	.0052876	-2.43	0.017	-.0233161	-.0023761
y2008	-.014989	.0053787	-2.79	0.006	-.0256394	-.0043387
y2009	-.0077184	.0060657	-1.27	0.206	-.0197291	.0042924
y2010	.0043611	.005135	0.85	0.397	-.0058068	.0145289
y2011	-.0106196	.0055603	-1.91	0.059	-.0216295	.0003902
y2012	-.0087579	.0049921	-1.75	0.082	-.0186428	.001127
y2013	.004547	.0054436	0.84	0.405	-.0062319	.015326
y2014	-.0071222	.0049699	-1.43	0.154	-.0169631	.0027187
_cons	.1502484	.1018921	1.47	0.143	-.0515081	.3520048
sigma_u	.06437028					
sigma_e	.02925703					
rho	.82878832	(fraction of variance due to u_i)				

Appendix 8: General Method of Moments Estimation of Operating Margin in relation to H-1B Hires, Employees, R&D, Advertising Spending, and Capital Expenditure

System dynamic panel-data estimation — Number of obs = 933
Group variable: gvkey — Number of groups = 120
Time variable: fyear
Obs per group: min = 1, avg = 7.775, max = 13

Number of instruments = 108 — Wald chi2(18) = 142.50
Prob > chi2 = 0.0000

One-step results

OpMargin	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
OpMargin						
L1.	.6417013	.0917651	6.99	0.000	.4618451	.8215576
ln_H1B	.0035717	.002193	1.63	0.103	-.0007266	.0078699
ln_emp	.0084402	.0146279	0.58	0.564	-.0202299	.0371103
ln_xrd	.0109691	.0086835	1.26	0.207	-.0060502	.0279884
ln_ads	-.002449	.007085	-0.35	0.730	-.0163355	.0114374
ln_capx	-.001974	.007797	-0.25	0.800	-.0172558	.0133078
y2003	.0030024	.0085413	0.35	0.725	-.0137383	.0197431
y2004	.0030042	.0084457	0.36	0.722	-.013549	.0195574
y2005	-.0016121	.0073841	-0.22	0.827	-.0160848	.0128605
y2006	-.0068915	.0068763	-1.00	0.316	-.0203688	.0065857
y2007	-.0038667	.0060588	-0.64	0.523	-.0157418	.0080083
y2008	-.0069038	.0059665	-1.16	0.247	-.0185978	.0047903
y2009	.0027236	.0069982	0.39	0.697	-.0109925	.0164398
y2010	.0097059	.0062487	1.55	0.120	-.0025413	.021953
y2011	-.0114511	.0054724	-2.09	0.036	-.0221769	-.0007253
y2012	-.0089642	.0048222	-1.86	0.063	-.0184156	.0004873
y2013	.0064509	.0055328	1.17	0.244	-.0043932	.0172951
y2014	-.0095667	.0059289	-1.61	0.107	-.0211872	.0020537
_cons	-.1225064	.2205839	-0.56	0.579	-.5548429	.3098302

Instruments for differenced equation
GMM-type: L(2/.).OpMargin
Standard: D.ln_H1B D.ln_emp D.ln_xrd D.ln_ads D.ln_capx D.y2002 D.y2003 D.y2004 D.y2005 D.y2006 D.y2007 D.y2008 D.y2009 D.y2010 D.y2011 D.y2012 D.y2013 D.y2014
Instruments for level equation
GMM-type: LD.OpMargin
Standard: _cons

Appendix 9: Hausman Test for Fixed Effects Regressions

Test for R&D Spending (Dependent Variable) Regression

	Coefficients (b) fe	(B) re	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
L.ln_xrd	.7901216	.9621929	-.1720713	.0123477
ln_H1B	.0222221	.0209385	.0012836	.0039425
y2003	-.0574916	.0059343	-.0634259	.0055041
y2004	-.0264053	.0477675	-.0741727	.0050931
y2005	-.0173717	.0426793	-.060051	.0034209
y2006	.0083815	.0702962	-.0619147	.0024464
y2007	-.0066875	.0408037	-.0474912	.
y2008	-.023419	.0153009	-.0387199	.
y2009	-.0757858	-.0459882	-.0297976	.0037145
y2010	-.0050014	.0360113	-.0410127	.
y2011	.0282864	.0615613	-.033275	.
y2012	.0070448	.0240295	-.0169847	.
y2013	-.0159049	-.0061381	-.0097668	.
y2014	.0216827	.0289734	-.0072907	.

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(14) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 436.18
Prob>chi2 = 0.0000
(V_b-V_B is not positive definite)

Test for Operating Margin (Dependent Variable) Regression

	Coefficients (b) fe1	(B) re1	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
L.OpMargin	.5070294	.9376661	-.4306367	.02837
ln_H1B	.0005176	.0002776	.0002401	.0011476
ln_xrd	-.0027864	.0018605	-.0046469	.0048803
ln_emp	-.0033605	-.0038487	.0004882	.0057008
ln_ads	-.0103929	.0000164	-.0104093	.0030688
ln_capx	.0139895	.0018196	.0121699	.0034116
y2003	-.0099887	-.0046251	-.0053636	.0014927
y2004	-.0079335	-.00303	-.0049035	.001403
y2005	-.0089606	-.0051113	-.0038494	.0007788
y2006	-.0146229	-.0121349	-.002488	.
y2007	-.0128461	-.0082983	-.0045478	.
y2008	-.014989	-.0102327	-.0047563	.
y2009	-.0077184	-.0031669	-.0045515	.0009814
y2010	.0043611	.007625	-.0032639	.
y2011	-.0106196	-.0127488	.0021291	.
y2012	-.0087579	-.0083861	-.0003718	.
y2013	.004547	.0076294	-.0030824	.
y2014	-.0071222	-.0105087	.0033865	.

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(18) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 235.19
Prob>chi2 = 0.0000
(V_b-V_B is not positive definite)

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